Technological extension program pilot project implemented in the capital goods sector in São Paulo - Brazil: promoting technological innovation

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ABSTRACT

Technological extension is recognized by the Organisation for Economic Co-operation and Development (2005, OECD) as fundamental for economic development, by promoting and stimulating further technological innovation, especially in small and medium-sized enterprises (SMEs). Despite its importance, particularly with respect to the impact of public or private initiatives that promote technological extension within the SMEs, the technical literature is not abundant on this subject and just a few case studies can be found. Moreover, development of structured extension programs based on the transposition of experiences between countries is very complex, mainly due to the diversity of economic, cultural, political and technological realities. Another important challenge is related to the concept and the structural base of the technological extension. This paper is written using the methodological reference and systematization of information available in the bibliography from the OECD. Based on this reference, the Ministry of Science and Technology of Brazil started four pilot projects to be implemented in São Paulo, Paraná, Santa Catarina and Bahia. These projects had two main objectives of putting in practice the technological extension service and analyzing its impact on firms. This article presents the process of implementation of the pilot in São Paulo. In this project, fifty firms of the capital goods sector were investigated. The results were the following: many firms showed improvement in the management of the production flow, a more consistent planning, a better control of many phases in the activity of the firm and increases in productivity. Based on these results, it can be concluded that the pilot program's technological extension proved to be relevant to SMEs due to specific management actions focused on the real needs of each firm, combined with the technological support provided and the low financial investment made by firms. Since this is a new and unknown project to most firms, many businessmen manifested doubts and uncertainty concerning the program. In this sense, after the evaluation of the whole process of implementing the pilot project, it was suggested to extend the same project to economic sectors in São Paulo. With this enlargement, it is intended to achieve a better promotion and publicity as well as adopting the concept of the technological extension. The program became effective as a part of the Science, Techonology and Innovation Program promoted by the Brazilian government.

INTRODUCTION

This article aims to present the experience of a pilot project on technological extension in the state of São Paulo, Brazil. It also proposes to show the relationship between the concept of technological extension and the applied technological innovation within SMEs, pointing out strategies and appropriate tools to achieve this demand.

For these purposes, the first section of this paper shows the importance of SMEs for one country's economy, providing a brief history of the SMEs in Brazil, and it continues by discussing the relevance of the introduction of technological innovation within SMEs and the its wealth creation impact. In the second section, it is presented a brief discussion about the diffusion of technology in OECD countries, as well as the collaboration from Brazil on the governmental initiatives related to the main subject. The concept of technological extension is presented as a tool to extend the diffusion of technology to support SMEs. The section concludes showing a framework of the capital goods sector and its importance to industry. In the following sections it is included the methodology and results. Finally, some considerations were made in the concluding section.

THE ECONOMIC IMPORTANCE OF SMEs AND TECHNOLOGY

The importance of the small and medium-sized interprises (SMEs)

The main role of a big company concerning the economic context of a country is largely understood and respected. Although there are some studies (Audretsch, 2004) that focuses on the increasing importance of the impact from SMEs in the economy, particullary in their participation/colaboration in industrial production and their capacity of creating employment and wealth.

In 2001, in Brazil, according to the data from RAIS - MTE (*in* SEBRAE, 2003) the number of companies was 5,57 million, 99,6% of which were SMEs. In these companies there were 14, 6 million of employees.

In the industrial sector there is also a big number of SMEs, in real numbers they are 987 thousand. That means that 5,01 million of people are employed in those companies. The micro and small-sized enterprises were responsable of 28% of production, and the other medium and big companies were responsible of 72% of production (SEBRAE, 2003).

In the year 2000, concerning export data, 63,7% of exports, in value, were from micro and small enterprises, the medium sized enterprises exported 19,6% and the big sized enterprises exported 6,9%.

The international report from Global Entrepreneurship Monitor (GEM, 2004), emphazises the importance of SMEs in the economical context of Brazil, reinforcing the existence and strength of policies, and technological developing programs, that stimulate entrepreneurship, particullary those dealing with:

1. The strenghtness of a global market structure;
2. The technical training of intrepreneurship;
3. The existence of conditions that enables firms to have a better market efficiency, global capacities, techonological transaction data and export market.

It is worth to refer that most of the topics above are suggested to be implemented in countries with low wages and low technological development. Although the above mentioned bibliographies refer all the important data, there is a low performance of SMEs concerning the technological dimension, which will be referred in the next chapter.

Technological innovation and SMEs

In OECD (2005), the importance of using science, technology and innovation to achieve economic and social goals is stressed. This environment has been heavily influenced by the increasing competitiveness of all country members from OECD. It also incentivates the creation, diffusion and exploitation of scientific and technological knowledge, as well as other intellectual goods, in the way of improving development and productivity.

The relation between technological innovation and economic development is largely recognized and acceped. Technological innovation should lead a firm to competitive advantages, either by reducing costs through a new production process, or through logistics simplification processes (Porter, 1990), or by differenciation, development of new products and improvement of already existent products, concerning their specifications, quality or flexibility.

To stimulate the theme discussion about technonolgy it is necessary to deal with the term “technological innovation” and its results. There are two possible references that are used in this paper. The first is the Survey of Technological Innovation - PINTEC (IBGE-Brasilian Institute of National Statistics and Geography, 2000). This reference works with the subject according to the orientation of the Frascatti’s and Oslo’s Manuals, both published by the OECD. These manuals are used by each country member from OECD as a reference to collecting statistic data in the area of science and technology. The second reference is the National Quality Foudation (FNQ), that works with other orientations related to National Quality Awards in other countries.

Technological innovation is defined in PINTEC (2000) as: “the implementation of technologically improved products (goods or services) or processes or new products”. Meanwhile the definition of marginal and substantial changes is established by each firm. Different types of innovation might occur simultanally or in an independent way, that means, a product innovation may be created, and its production could be made in a conventional way regarding technology, or it may require a process innovation.

According to the FNQ innovation is considered as “the promotion of big changes that lead to improve the process and products in the organization and the creation of additional in value for both parts”. Both concepts have in common the idea of improving product and process, however it is also important to gather some value to both parts. To be considered innovation it is not enough to improve the process/product. An innovation should obtain a result after its implementation, that means it must be considered from the efficiency perspective. To set some value it is necessary to reduce losses during the productive process, to reduce activities that do not bring new value and to improve the material and information flux.

The concepts used by PINTEC argue that the innovative activities and the implementation of technological innovation might be developed within the firm or throught the acquisition of goods, services and external knowledge. The firm that develops internally innovation mades it through activities of R&D, that may be in a continuous or ocasional way. It mayalso be formal, when there is a formal structure within the organization of the firm; or informal when it does not occur within a formal structure, i.e, staff and materials used in other functions are also used to those activities.

Asides from R&D, there are firms that implement several innovative activities trough the incorporation of new technologies, for instance, the acquisition of technology introduced in machinery and equipaments

technologically more advanced than those used; the acquisition of external knowledge (know how); external R&D (firms or laboraties to execute R&D activities which the firm cannot execute); training; marketing and advertising, market research and industrial structural changes that allow the registration of the final product/label.

- Concerning the above mentioned activities, some data from PINTEC (IBGE, 2000) show that, considering 72 thousand industrial firms with 10 or more employees, 22,7 thousand of firms (31,5%) had implemented innovations actions, with an investment of R$ 22,35 billion, the equivalent to 3,8% of its cash flow. See table 1, in annex.

Considering Table 1 and the total of investment in innovation, we see that 52% were destined to the acquisition of goods, which agrees with the above mentioned references opinions. However, large firms (with more than 500 employees) are at the front line with 68,4%, and meanwhile the same index falls down to 31,6% considering firms between 10 to 49 employees.

Considering the big number of micro, small and medium-sized enterprises, those correspond to more than 4,55 million of firms and more than 8,57 million of employees. This group of firms has an high impact. It might be important to elaborate on the possible comtetitveness impacts on those firms..

There are different competitiveness levels within SMEs, thatcould be better understood if four relevant aspects are considered:

1. Big firms have more R&D investment capacity and because of that more capacity to innovate. Another competitive advantage is related to easier and larger access to consumers markets, since they already have strong and solid structures with distribution channels and publicity investment;
2. Capacity to create employment: the big companies although being small in number, employ 56% of all employees, while the medium-sized enterprises employ 16%, and the other employees are employed by micro and small firms. In addition to that, the big firms tend to offer better work conditions and better salaries;
3. Capacity to export: it requires a certain articulation level, capacity to negotiate in international markets, the power to negotiate prices, organized actions, appropriate products and process which respect the international standards. The SMEs have “natural defects” related to how to learn to plan high impact strategic actions with longer timetables, managers limited technical capacity and low resources to invest in the export market;
4. A ¨natural facility¨ dealing with governmental credit lines for any purpose (export, production growth, R&D), particulary the availability to real guarantees, for instance, low taxes, nonrefundable. The above mencioned does not happen within SMEs.

In any case the improvement of competitiveness within SMEs could only be achieved with the improvement of internal systemic factors. In this context, technological management is brought up, herewith recognized as a sequence of necessary actions to identify, analyse, develop and test products before being in the production process, as well as process and services originated from business opportunities observed in a competitive environment (OECD, 1997).

DIFFUSION OF TECHNOLOGY AND RELATED PROGRAMMES

Technological diffusion in countries members from OECD and Brasil

According to OECD (1997) governmental initiatives should promote technological diffusion. Many studies on the technological effect in the productivity of industrial firms reveal that there is a big dependence on technologies developed in other place and not developed in the own company.

In this sense, the analysis of several governmental actions indicates that there is a kind of technological diffusion programs typologies, which have being constructed according to their aims, operational focus (previous demand) or specific group action. In general, these diffusion programs typologies act within the firms at three levels:

1. Programs that improve the absortion and adaptation of specifics technologies;
2. Programs that improve the capacity of firms which receive technologies to be used in general terms (technical assistance projects, and information networks);
3. Programs that build the whole capacity of innovation within the firms, including the use of tools as sectorial maps, diagnoses and benchmarking. The OECD (1997, pg.09) suggests four categories of technological diffusion programs based on their operational focuses:

   a) Supply-driven: actions that transfer and commercialize technologies of governmental research programs to private firms. These actions are directed to industrial firms with low technological capacity, as well as to high technological sectors. This model was adopted in Canada by “Canadian Space Agency”;

   b) Demand-driven: actions that usually are initiated by firms that aim to identified technological defects, considering both opportunities and needs from de marketing, particularly at small businesses.This model was adopted in the USA and by The Manufacturing Extension Partnership**;**

c) Network-based: most of these actions are executed at a regional level, guided by the institutions which promote partnership between the firms, essentially a technological information programme. This model was adopted in Netherlands by Dutch Innovation Centres,

d) Infrastructure-building: actions that deal with effective improvement of the technological diffusion system infrastructure at a national level. This model was adopted in Koreia by Regional Research Centres and in Brazil by the Science and Technological Ministery through Basic Industrial Technological Program.

It is worth to remember that there are many countries where there's a big diversity of technological diffusion actions, which reflect not only their innovation systems in general, but also their specific systems and the regional economic dynamics. The technological diffusion programs referenced by OECD show methodologies already consolidated in some country members and methodologies at an initial phase and implementation in the developing countries.

In general these methodologies are guidelines formulated in the governmental context and are articulated by different agents, for instance, universities, enterprises (particularly SMEs), non governmental organizations, and research institutes. These agents work together to formulate all actions and to promote innovation development in the country. Ttable 2 in annex represents some examples of technological diffusion programs adopted in the USA and Canada.

Both programs represented in table 2 are promoted by governmental entities in partnership with universities and technological institutes, which offer technological services specially within SME in the adaptation product area, process and administrative management. Another similar feature from these programs is the methodology used to offer a service: 1. The presentation program phase and diagnose made by expert; 2. Good practice proposal phase or improvement of organizational programs and, 3. Implementation proposal phase.

Technological extension within SME

Considering all strategic management factors, technological diffusion can be emphasize as the one being the most complex and of great risk, but at the same time being the one which has more potential to guarantee good results.

Aiming to reduce the risk of failure of technological innovations, especially those related to consumer goods, there is a need to merge the "market reality vision" with the "prospective market vision" in terms of novelty.

This fusion will occur only on its total plenitude, when the essential factors to the well known "good practices" in management and mainly at production are perceived/understood by customers in terms of improving the quality of products and services. These "good practices" consist of simple actions, low cost and high impact at production and development, involving the revision or improvement of product/process, and that are appropriate to the business at stake/in question.

In this sense, the prospective market vision deals with the sense of the novelty, which can arise by an implicit perception (market push), or as a positive attitude of acceptance of certain technical feature (technology pull). The process, product or service that may arise would be affected in/at applied research and still being tested in a format product/process and technology.

These moves follow the strategies of firms in two models presented as Imitative or Innovative Model (Hayes and Wheelright, 1984). The technological institutions that have a concern with education, development and dissemination of technologies can be brought closer to the reality of companies, universities and research centers.

These technological institutions, in most cases, have as a mission the training of personnel for technical and technological professions and the provision of technological services, which do not necessarily include the advancement of knowledge from research institutions, because they are more related to technical training and assistance to the dissemination of basic knowledge of production processes. These resources of knowledge are prepared to address the needs of the majority of micro, small and medium-sized enterprises.

Likewise, the universities and research institutions should be recognized as institutions prepared to assist in the above mentioned "prospective vision". When we identify the "arm" of the research, because of dealing intensively with the advancement of knowledge and interaction in a scenario without borders/obstacles. Another arm, the one from extension seems to be stigmatized in the traditional way in continuous knowledge, that means, courses or training. The partnership projects between universities (research centers) and companies that aim technological advancement may lead to an interaction between the business and science vision.

In this case, the adjustments of the forms of action aiming to a greater interaction should be developed not as simple contracts for commercial purposes, but as partnerships between the "technological experts" and "market experts". In this context this partnership should occur by presenting each part its "core business", even though the results are at the beginning not satisfactory. The adjustments in focus and in the daily practices of both institutions are expected and include, among other activities, the development and use of knowledge in

issues of confidentiality of information, in timing of the request and response and on the work methods that should be developed or adapted.

The process of developing products and processes is the responsibility of companies. The natural risks that arise from testing new technologies, can be minimized with the use of partnerships between state, technological centres/research and companies.

In this sense, companies should not be waiting for research centers to develop complete products or processes, but they should develop their own prototypes and tests in laboratory scales. As a result, some scientific articles arised and eventually some patents, specifically for products or processes. This is a real result from the capacity of the company to innovate, of great strategic importance due to differentiation, even temporarily, of products and services from the competition and the consequent opening, maintaining and growing market.

How to trasmit/pass accumulated knowledge from universities and research centers to the public opinion without using the traditional extension concept from the university? One answer lies on the well known technological extension concept, recognized has having big impact at the economic development by the OECD. The technological extension is considered an important action within the context of leveraging technological innovation in SMEs. In the reference books from OECD (1997) there are reports from the beginning of 90ies from some country members that have launched initiatives and consulting services for networking, using Information Technology - IT. The aim was to help companies to adopt new management good practices, to implement organizational changes and to direct habilities of workmanship considering the interest of general improvement, all around innovative capacity and use of technologies.

To direct the research study within SMEs, it appears to be lacking some basic systems of quality management and strategic vision of their managers. It is considered, besides the factors of cash management, staff and production, the awareness of the importance and the need for further investment in time, as well as the accumulation of knowledge, financial, material and human resources to improve competitiveness. These topics are the main factors that imped/threat the innovation process. Thus, the companies that have growth potential with the aid of technological extension services can be internationally very strong and disseminate the culture of innovation and therefore be able to continue progress in R&D activities.

Moreover, technological institutions seem to be the most appropriate place for the development of technological extension services, requiring it to:

1. Methodologies of attendance and managerial and technical advices (proposals), assistance (to do with the firm) and services (to execute or provide services outside for firm);
2. Trained and qualified personnel in the methodology;
3. A technological network that links these institutions and services of the technological extension, the research centers and universities.

Today, the actions related to extensionism are not sufficient to meet the needs of SMEs. Several problems can be pointed in the actions and potential customers, according to the author's view:
1. Lack of an appropriate methodology to various kinds of economic, technological and social changes that affect SMEs;
2. Lack of qualified staff to attend for the SMEs;
3. Lack of focus on technologies that are considered basic and concern with problems that often boil down to investments in machineries;
4.Attendance of the variety of demands; industries, commerce and service, without any specifics for sector of the industry;
5. exclusion of the SMEs.

Capital goods sector specification

The capital goods sector includes a set of machinery and equipments manufacturing firms, which are responsible, to a great extent, for the capacity of production of other products. A capital good may be thus considered when it is used in the productive process of other goods and services.

The capital goods sector is directly related to the value chain of the other industrial sectors, but it is also a consumer of goods produced by itself . In this manner the capital goods sector has an important role in the diffusion of new technologies and as a dynamic economic growth sector. It gathers several kinds of products used for many purposes, which can be divided as follows:

- Mechanical capital goods – mechanics, mechanical equipment, industrial equipment, agricultural machinery and implements, mining and road machinery;
- Transportation equipment - buses and trucks, naval, aeronautic industry;
- Electric/electronic capital goods – electric and electronic equipments.

Therefore the capital goods sector is directly related to other production sectors and has a relevant role concerning the diffusion of new technologies (Sandven et al, 2001). It could be distinguished by its heterogeneity, (different uses and kinds), purposes and client sectors (chemical, petrochemical, metallurgic, textile, shoes, electric, paper and cellulose, food, etc.).

In Brazil the firms dealing with the capital goods sector are leaded by the dynamics of other industrial sectors. These firms work for those other sectors, producing their equipments. The producers of capital goods dealing more with the internal market show, in a general way, a low innovative effort, which reflects the features of those firms that buy those goods, as well as a continuous and slowly machinery obsolescence.

The national producers have the need of developing product technologies with a broader internal scope. However interactions with universities and research institutes are low, in other words, ther is insifucciente use of the available national and reduced sources of knowledge. The majority of firms within this sector reveal the difficulty of developing projects together with other firms, research institutes and universities, claiming timing divergences.,. At the same time, many firms have also admitted that they can not spend more efforts to set a long term bound with those educational and research institutions. The way to be in continuous contact with the market is made directly through market fairs, making thus contact with customers and suppliers to decide technological strategies.

METHODOLOGY

This study was conducted in fifty SMEs in the capital goods sector in São Paulo state. This pilot project was implemented in partnership with Ministry of Science and Technology of Brazil, which allocated the funds for the project, and the Institute for Techonological Research – IPT, from São Paulo, that executed the project.

The project was developed by presencial and laboratorial actions, aiming at product and proecc flows , in a way that indicators about the period before and after those actions could be obtained. Thus it was possible to build a comparative framework. The work IPT conducted managed within the firms was as following:
1.Directional service to the management of products and process flows ;
2. Use of national and international technical standards, technical regulamentation to be applied to the product and embedded in good practices of production to be implemented;
3. Corrections on the management of the process flow and on its associated variables;
4. Consultory and/or recommendations on general problems diagnosed within the firms, with long or medium term impact;

The first phase was to achieve a technical diagnose, which was gathered trough data collection the productive process in a general way and its variables (cost, time, rework, stock, defects, delivery time conditions). In this manner, the data which was set could help to identify and to dicuss all the envolved aspects of the productive flux, considering the management, organizational, productive, financial, administrative, data flux and technological difficulties level.

The second phase was to constitute a relantionship between the above mentioned topics and after that to selected the most important to the costumer. In a way that could be used to focus on the aspects wich should disseminate correlated actions within the firm. A global methodology was then proposed to serve the aims and to set up a work plan to be discussed and approved by the businessman. After the approval a work cronogram was prepared within the firm, so that the identified actions could take place.

RESULTS

The maisn results achieved by SMEs were the following:

1. Costs reduction without reducing operational capacity:
2. Planning improvements and a better control of the material and production processes;
3. Stock reduction:
4. Better punctuality delivering their products.

It can be deduced that the pilot program's technological extension proved to be relevant to SMEs due to specific management actions focused on the real needs of each firm. In the beginning this was a new and unknown project, and many businessmen manifested doubts and uncertainty concerning the program. But after the evaluation, the process of implementing the pilot project was suggested, executed and further extended to other sectors in São Paulo. With the enlargement, it was achieved a better promotion and publicity as well as the adoption of the concept of technological extension. The program became thus effective as a part of the Science, Technology and Innovation Program promoted by the Brazilian government.

During this work, it was possible to be aware of a new perception of the real technological development at the capital goods sector. It was observed the opportunities and tendencies among other researchable topics.

In these sense this work contributed also to the industrial politics in the sector, searching for a better dynamism, technological independence, competitiveness, as well as to the industry and economy of Brazil. The politics experts agree with the study and therefore decided to discuss some new politics, considering the productive and technological development of the national sectors in general, specific in the capital goods sector.

CONCLUSION

Innovation is fundamental to the strategic industrial development of a country. The use of new technologies

within the firms implies assuming inherent risks on development, production and the pilot commercialization of products and services. The strategy used to innovate becomes an important factor to improve competitiveness.

Innovation is not associated only to the desirable speed of high competitive environments. It should be present in simple solutions, systemic and not restricted to R&D areas. It should also include main aspects from the business of the firm.

In this context, the government has an important role as an introducer of innovative technological processes within firms and thus promoting cooperative actions/initiatives (technological institutes), financial resources and support to the implementation of technological programs, as a form to strengthen the economy, and the creation of wealth and employment.

It should be emphasize the role of the technological extension programme at progress, which has contributed to create an competitive environment to innovation, offering SMEs an appropriate technological infrastructure of experts, services and kowledge centres. It thus contributes to the strengthen of the technological plataforms of a country, focusing on the constitution of a prosperous society kown as knowlede society.

The program has revealed to be of great importance to the SMEs. These firms were supported because of their management actions focused at their real needs, bound to technological support and low investment. The suggested actions always have been taken considering the actual/real resources of each firm.

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Attached

Table 1 – Finantial Investment Distribution (%) in Innovation according the firm size

Kind/type of Innovation	Distribution (%) of the total investment (R$ 22,35 billion)	Distribution (%) according the firm size		
		10 to 99 employees	100 to 499 employees	More than 500 employees
Equipment and machinery acquisition	52,2	71,73	64,69	43,11
R&D Internal Activities	16,75	10,07	11,66	20,17
Industrial Project and other technical prepares	14,76	9,5	11,84	17,05
Introduction of Technological Innovation in the market	6,26	3,22	3,99	7,96
Other External knowledge acquisition/contract	5,26	2,04	4,80	6,12
Trainning	2,82	1,04	1,01	3,90
R&D External Acquisition	1,87	2,40	2,01	1,96

Source: IBGE, Research Directory, Department of Industry, Industrial Research – Technological Innovation, 2000

Table 2 - Examples of Technological Diffusion Programs in the USA and Canada and its action/proceeding areas within SMES

INSTITUTION - COUNTRY	PROGRAMS	*action/proceeding areas*	
		PRODUCT and PROCESS	GESTÃO ADM
National Institute of Standards and Technology - EUA	Manufacturing Extension Partnership (MEP)	Lean Manufacturing Quality and Certification Enviroment, health and security	Strategic management Information Technology - IT Human resources magnagement
National Research Council Canada - Canadá	Industrial Research Assistance Program (IRAP)	Lean Manufacturing HPM – High Performance Technological Manufacturing Technological Transference Intelectual Property Technological Information and services network	Business excellence Information Technology - IT

Source: MEP, 2005; IRAP, 2005.